# METHOD FOR RE-ROUTING DATA PACKETS OF A PACKET SWITCHING NETWORK ONTO AT LEAST ONE ALTERNATIVE NETWORK

The invention is directed to a method for re-routing data packets of a data switching network onto at least one alternative network that assures a quality required for these data packets, according to the preamble of patent claim 1.

In a packet-switching network such as, for example, the Internet, which is usually composed of a plurality of sub-networks, data packets from a source node are potentially transmitted to a destination node via a plurality of intermediate and/or access nodes of the individual sub-networks. In addition to containing information, the data packets particularly contain a destination address. The intermediate or, respectively, access nodes contain what is referred to as a routing table for determining a traffic path in which each destination address of a data packet has a destination address of that node (i.e. intermediate or, respectively, access node) to which the data packet is forwarded allocated to it. When, thus, a data packet arrives at such a node, the data packet is forwarded to the node corresponding to its destination address entry in the routing table.

The data transmission in such a packet-switching network is normally connectionless, i.e. the data packets with identical source and destination address are transported independently of one another, so that neither the sequence nor a delivery of the data packets at the destination node is guaranteed (OSI layer 3 protocol). A quality of the transmission of data packets between source and destination node such as, for example, a certain bandwidth, delay times and a specific throughput can therefore also not be promised.

In particular, video transmission services (for example, video on demand) and various telephone services (for example, voice over IP) in the Internet require a dependable and fast data transmission with an assured quality.

An "Internet Draft" document authored by K. Nichols and S. Blake that was published by the Internet Engineering Task Force in February 1998 (Internet site:

http://www.ietf.org/internet-drafts/draft-nichols-dsopdef-00.txt) proposes a method that enables an accelerated transmission of data packets from a source node to a destination node.

For data packets to be forwarded especially fast, specific bits of what is referred to as the TOS byte in the header part of such a data packet are set. Such data packets can be divided into various classes on the basis of the bits that are set in the TOS byte. According to their class, the data packets identified with the set bits are given privileged handling in the intermediate nodes via which such data packets are transmitted from the source node to the destination node, as a result whereof, in particular, an accelerated forwarding to the next node (intermediate or destination node) is achieved.

A critical disadvantage of this method is to be seen therein that the privileged handling in the forwarding of the data packets identified with the set bits leads to considerable delays in the forwarding of the data packets to be transmitted "normally".

Moreover, it is not only the destination addresses but also the respective TOS bytes that must be taken into consideration in every intermediate node when forwarding the data packets.

Another "Internet Draft" document authored by Y. Bernet, R. Yavatkar, P. Ford, F. Baker and L. Zhang that was published by the Internet Engineering Task Force in March 1998 (Internet site: http://ietf.org/internet-drafts/draft-bernet-intdiff-00.txt) presents a method that, with the assistance of the above-explained method, combines a plurality of demands made of the Internet for a guaranteed quality for the transmission of data packets into classes. A corresponding quality for the transmission of data packets is assured according to such a class.

Since a required quality for the transmission of data packets with a privileged handling thereof on the basis of the aforementioned, set bits in the TOS byte is assured, this method can be reduced to the initially explained approach. The disadvantages that were already initially mentioned therefore remain.

Another approach to offering the user of, for example, a video transmission service a bandwidth requested by the user for the transmission of data packets is disclosed by US Patent Application 5,732,078.

This discloses an arrangement of an access node to the Internet that assures a bandwidth requested by the user for the transmission of data packets by re-routing data packets onto an alternate network. The re-routing of the data packets is thereby undertaken as follows:

When a user requests a specific bandwidth for the transmission of data packets from his user terminal device to a destination node, the access node to which the user terminal device is connected sets up a point-to-point connection to the access node to which the destination node is connected via the alternate network offering the requested bandwidth.

For re-routing the data packets for whose transmission the user requests an assured bandwidth onto the alternate network, an existing routing table in the access node to which the user terminal device is connected is finally modified such that, in addition to containing the respective destination addresses of the nodes to which data packets are respectively forwarded, it also contains the source addresses of the data packets to be re-routed due to a quality requested by the user. According to a modification of the appertaining, known method, a connection-individual or, respectively, transmission-individual particular ("application port number") is additionally entered into said routing table.

On the basis of the additionally stored source address and, potentially, the aforementioned connection-individual or, respectively, transmission-individual particular ("application port number") in the routing table, the data packets arriving at such an access node can be selected according to whether they are routed over the ordinary Internet or via the alternate network.

This method is very involved since a separate connection via the alternate network must be set up for every transmission of data packets with a requested bandwidth that is initiated by a user.

Additionally, the routing table must be modified in every access node to which user terminal devices are connected, namely after every transmission of data packets with a specific bandwidth initiated by a user.

Also to be considered as further outlay is that all data packets incoming at such an access node are investigated for their source address and, potentially, the aforementioned connection-individual or, respectively, transmission-individual particular ("application port number"), with reference whereto a re-routing onto the alternate network can be initiated.

Finally, it is also known (Gung-Chou Lai, Ruay-Shiung Chang, "Support Qos in IP over ATM", Master Thesis [Online], June 1997 (1997-06), National Taiwan University of Science and technology, Taipei, Taiwan) that a determination regarding the path via which a data packet is to be routed in a switching system can be made in the switching system on the basis of a field TOS (type of service) in the header of data packets to be switched or, respectively, to be transmitted. This measure, however, has nothing to do with a re-routing of data packets of a packet-switching network onto at least one alternate network; on the contrary, the data switchings or, respectively, transmissions here respectively ensue in one and the same switching system.

The object of the invention is therefore comprised in developing a method of the species indicated in the preamble of patent claim 1 to the effect that it can be implemented with optimally little outlay and with the slightest possible effect on its environment.

The object is achieved by the features recited in the characterizing part of claim 1.

The principle of the invention is comprised in re-routing data packets of a packet-switching network for whose transmission between their source node and their destination a specific quality is requested onto at least one alternate network that assures such a requested quality. This re-routing is inventively achieved in that the data packets to be routed via an alternate network are respectively identified in their source node only by a bit pattern known to the access node connected to the source node either directly or indirectly via at least one intermediate node. Upon arrival of such data packets in such an access node, the known bit patterns are respectively recognized only as a result thereof, and a re-routing of the data packets identified with the known bit patterns onto an alternate network is initiated.

A critical advantage of the inventive method is to be seen therein that the table present in an access node connected to such a source node for determining the traffic paths (routing table) remains unaffected by ongoing modifications for the re-routing of the data packets for whose transmission a specific quality has been requested.

It has also proven advantageous when data packets need be investigated for the known bit pattern only in the access node connected to a source node.

The invention is additionally characterized in that the traffic flow of the ordinary packet-switching network is not negatively affected by the re-routing of the data packets for whose transmission a requested quality is to be assured with the assistance of the inventively simple selection according to a known bit pattern.

Further developments of the invention are recited in subclaims.

According to an advantageous development of the invention, the data packets arriving in an access node directly or indirectly connected to a source node

proceeding from the source node are checked with a filter for a bit pattern known to the access node. When a known bit pattern has been recognized, then the re-routing of the data packets identified with such a bit pattern onto an alternate network is initiated. This procedure is beneficial particularly because it is no longer all data packets arriving at the access node but only a significantly lower plurality of data packets, namely those coming from a source node, that must be investigated for the known bit pattern. What is also thereby avoided is that data packets that are sent from the destination node back to the source node, for example for the purpose of an acknowledge, are re-routed onto the alternate network, as a result whereof the data packets are unintentionally sent in a circle.

Another advantageous development of the invention provides that the function of the filter is integrated in a table for determining the traffic paths (routing table) that is present in such an access node. This occurs with an additional entry of the known bit pattern that can produce a re-routing of a data packet identified with such a bit pattern onto an alternate network. In that memory structures that are already present can be utilized in the integration of the function of the filter into the routing table, the implementation outlay of such a filter is substantially reduced.

According to a useful development of the invention, such a known bit pattern is located in the header part of a data packet to be routed via an alternate network. As a result thereof, the data packets can be designationally and, thus, quickly investigated for the known bit pattern.

According to one development, the inventive method uses the respectively same bit pattern for identifying data packets to be routed via an alternate network, regardless of the respectively requested quality. The investigation of such data packets for a known bit pattern is considerably simplified as a result thereof. Further, the data packets for whose transmission a respectively different transmission quality is requested are combined into a class, so that the alternate network need offer only one of the requested qualities for the transmission of these data packets.

As an alternative to the aforementioned development, the source nodes can also employ different bit patterns for identifying such data packets, these different

bit patterns corresponding to the respectively requested quality. This has the advantage that such data packets can be divided into classes according to their requested quality. The alternate network can thus offer the quality corresponding to a class for the transmission of the data packets.

In conjunction with the above-described development, another embodiment of the invention provides that each recognized bit pattern of a data packet produces a re-routing thereof onto an alternate network with a requested quality that corresponds to the bit pattern. In other words, data packets of a class are re-routed onto one of the possible alternate networks that corresponds to the bit pattern of the class and offers the quality requested by the class.

As an alternative to the aforementioned embodiment of the invention, each recognized bit pattern of a data packet can produce a re-routing thereof onto a single alternate network that assures the quality that corresponds to the bit pattern and, thus, to the class of the data packets.

The above-presented developments for dividing the data packets into classes corresponding to the requested quality offers [sic] the advantage that an alternate network need not explicitly offer the respectively requested quality for each transmission of data packets to be undertaken.

After recognition of such a bit pattern of a data packet to be routed via an alternate network in such an access node, the re-routing of the data packet onto an alternate network can be prevented according to another advantageous development of the invention when the alternate network cannot offer the quality corresponding to the bit pattern. In this way, such an access node can defend such an alternate network against data packets that lead to an overload.

An advantageous development of the invention provides that the source node that intends to send data packets communicates a message to its destination node via the packet-switching network with respect to the data packets to be routed via an alternate network and potentially waits for an acknowledge from the destination node. A secured connection setup of a point-to-point connection between the source and the destination node is achieved as a result thereof.

Another development of the invention is comprised therein that the access node directly or indirectly connected to such a source node sends a message with respect to the quality to be assured as requested by the source node to the network node of an alternate network and potentially waits for an acknowledge therefrom. This procedure serves the purpose of a dependable offering of the requested quality by the network node of the alternate network.

A further advantageous development of the inventive method can be seen therein that the method is applied to a network constellation wherein such an alternate network is formed in that at least one logical channel of the packet-switching network is reserved for the data packets to be transmitted with an assured quality. I.e., an alternate network is composed of one or more logical channels of the packet-switching network. This represents an especially cost-beneficial solution since additional connecting lines for the alternate network are thereby eliminated.

An exemplary embodiment of the invention is explained in greater detail below with reference to a drawing.

The Figure shows a portion of a communication network on which the inventive method can be applied by way of example.

Accordingly, the Figure shows two source nodes U1, U2 of a plurality of conceivable source nodes and one of many possible destination nodes Z. The two source nodes U1, U2 are connected to an access node ZK1 and the destination node Z is connected to an access node ZK2, either directly or indirectly via respectively one or more intermediate nodes ZW1, ZW2, as indicated in the Figure by the intermediate node ZW1 shown with broken lines between U1 and ZK1 and the intermediate node ZW2 shown with broken lines between ZK2 and Z. The access nodes ZK1 and ZK2 belong to a packet-switching network PN and respectively form an access to one or more alternate networks AN1 through ANn at the same time. Such a packet-switching network could, for example, be the Internet, within which mainly variable-length data packets are transmitted, or could also be an ATM network (asynchronous transfer mode), within which fixed-length data packets (ATM cells) are usually transported. Given the pre-condition that it assures a requested quality for the data

transmission, such an alternate network can be formed by an arbitrary network type, for example a line-switching network, a packet-switching network or an ATM network. Such an alternate network can also be composed of at least one logical channel of the packet-switching network PN.

Normally, data packets are sent to an access node, for example ZK1, to the packet-switching network PN from the source node either directly (for example, proceeding from U2) or indirectly (for example, proceeding from U1) via one or more intermediate nodes, for example ZW1. From the access node, they are sent via the packet-switching network to another access node, for example ZK2, and are sent from the latter to a destination node Z either directly or via one or more intermediate nodes, for example ZW2. A transmission of data packets in the opposite direction is likewise conceivable, i.e. with the destination node as source node and with the source node as destination noodle.

In view of the overall communication network, the indicated source node and the destination node can be respectively interpreted as intermediate node of end node of the communication network. Such end nodes can thereby be viewed as computer of a service vendor or as a data terminal device of a user.

In the present example, a user would like to have his data terminal device, for example U1, receive an Internet service, for example video on demand, from a computer, for example Z, of a service vendor. For the transmission of data packets of such a service, a certain quality in the form of a specific bandwidth must be assured at the network side. The bandwidth needed for the service can be offered be re-routing the data packets belonging to such a service onto an alternate network that assures the requested quality.

Accordingly, the source node, for example U1, sends a message to the access node ZK1 either directly or indirectly via at least one intermediate node, for example ZW1, this message containing a request in the form re-routing data packets for whose transmission a specific quality, for example bandwidth, is required. In the form of a message, the access node communicates the bit pattern with which the data packets to be routed onto the alternate network are identified to the source node U1

and additionally acknowledges the message with the request sent from the source node U1. Further, the access node sends a message about the quality requested by the source node to the network node (not shown in the Figure) of an alternate network, for example AN1, and potentially waits for the acknowledge thereof. The source node U1 identifies the data packets that are to be transmitted via the alternate network with an assured quality with the bit pattern obtained from the access node.

As an alternative thereto, such a bit pattern can be known to the source node U1 according to a corresponding implementation without having to be previously informed thereof by the access node. Such a bit pattern is normally located in the header of such a data packet. In conjunction with the Internet, the bit pattern can be found in what is referred to as the TOS byte.

Before the source node U1 now sends the data packets -- for whose transmission a requested quality is to be assured and which are therefore to be routed via an alternate network – in the direction of the access node, it is possible that the source node communicates a message with respect to the [...] to be routed via the alternate network to its destination node data packets [sic] via the ordinary packet-switching network PN and potentially waits for an acknowledge from the destination node.

In the access node, the data packets arriving from the source node U1 are checked for the bit pattern with a filter (not shown in the Figure). The data packets wherein the bit pattern was recognized are re-routed onto the alternate network. Alternatively thereto, the function of the filter can be integrated into the routing table to be conceived of as being present in the access node in that the bit patterns that produce a re-routing of a data packet identified with the bit pattern onto the alternate network are additionally entered into the routing table.

Parallel to the above-described scenario with respect to the source node U1, the same scenario can be initiated by one or more other source nodes, for example U2.

Regardless of the respectively requested quality, the source node U2 possibly employs the same bit pattern for identifying the data packets that are to be

sent via an alternate network, for example ANn. Alternatively thereto, the source node U2 can use a bit pattern that corresponds to the requested quality for identifying the data packets to be routed via the alternate network.

In this way, the data packets sent in the direction of the access node from, under certain circumstances, a plurality of source nodes can be combined into classes according to the quality required for their transmission.

When the data packets to be re-routed in the access node can be re-routed onto a plurality of alternate networks, one bit pattern is defined [...] each alternate network. In this way, the data packets can be re-routed onto an alternate network corresponding to the bit pattern that assures the requested quality.

When only one alternate network is available for the re-routing of the data packets identified with a bit pattern, the quality to be assured by the alternate network can be offered according to the bit pattern of the identified data packets.

The access node can deny re-routing onto the alternate network for data packets that are identified with a bit pattern that does not correspond to the quality offered by the alternate network.

Mutually independent actions of the above-described scenarios can also run in an arbitrary sequence.